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Goat intake, diet selection and milk quality as affected by grazing time of day

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SUMMARY – Sixteen Girgentana lactating goats were divided in two experimental groups and housed in individual pens where they received 500 g/d of barley grain. The goats were left to graze on a *Lolium* sward, as follows: group 1, from 9:00 to 13:00; group 2, from 12:00 to 16:00. Herbage water-soluble carbohydrates (WSC) increased in the afternoon, whereas herbage crude protein (CP) content slowly decreased. However, selective behaviour allowed the morning group to assume a diet much higher in CP than the afternoon group (19.8 *vs* 16.7% DM). Pasture DM intake resulted significantly higher in the afternoon (825.4 *vs* 748.8 g/day; P = 0.01), whereas CP intake was not affected by treatment (149.6 and 150.6 g/d respectively morning and afternoon group; P = 0.11). Fat normalized milk production, milk fat and lactose content were not affected by treatment, whereas protein and casein significantly increased in the afternoon group (respectively 3.56 and 2.78 *vs* 3.42 and 2.65%; P<0.05). On the contrary, milk urea content resulted significantly higher in the morning group (38.0 *vs* 35.9 mg/dl; P = 0.05). These results seem to indicate that an improvement of ruminal efficiency could be obtained by shifting grazing time from morning to afternoon.

Keywords: Grazing time of day, goat, intake, diet selection, milk quality.

RESUME *– "Ingestion, sélection de l'alimentation et qualité du lait chez des chèvres selon le moment de pâturage pendant la journée". Seize chèvres allaitantes de race Girgentana ont été divisées en deux groupes expérimentaux et logées individuellement, et recevaient 500 g/j de grain d'orge. Les chèvres étaient au pâturage sur une prairie de* Lolium*, comme suit : groupe 1, de 9:00 à 13:00 ; groupe 2, de 12:00 à 16:00. Les hydrates de carbone hydrosolubles de l'herbage (WSC) augmentaient dans l'après-midi, tandis que la teneur en protéine brute de l'herbage (CP) baissait lentement. Cependant, le comportement sélectif permettait au groupe du matin un régime bien plus élevé en CP que chez le groupe de l'après-midi (19.8* vs *16.7% matière sèche). L'ingestion de matière sèche au pâturage était significativement plus élevée l'après-midi (825.4* vs *748.8 g/j ; P=0.01), tandis que l'ingestion de CP n'était pas affectée par le traitement (149,6 et 150,6 g/j respectivement pour les groupes du matin et de l'après-midi ; P=0.11). La production de lait à matière grasse normalisée, les matières grasses du lait et la teneur en lactose n'étaient pas influencées par le traitement, tandis que la protéine et la caséine avaient significativement augmenté dans le groupe de l'après-midi (respectivement 3,56 et 2,78* vs *3,42 et 2,65% ; P<0.05). Au contraire, la teneur en urée du lait a résulté significativement supérieure dans le groupe du matin (38.0* vs *35,9 mg/dl ; P=0.05). Ces résultats semblent indiquer que l'on peut obtenir une amélioration de l'efficacité ruminale en déplaçant le moment de pâturage du matin à l'après-midi.*

Mots-clés : *Moment du pâturage pendant la journée, chèvres, ingestion, sélection de l'aliment, qualité du lait.*

Introduction

Fresh herbage generally is characterized by high soluble protein content often associated to a not corresponding adequate level of water soluble carbohydrates (WSC). The unbalanced availability of N and energy sources leads to a low efficiency of milk protein synthesis. Van Vuuren (1993) reports that in grazing dairy cows this efficiency is as low as 20%. Moreover, a low level of WSC can cause an increase of blood level of urea and N urine excretion (Miller *et al*., 2001). For these reasons, a greater availability of sugars should result in an improvement of pasture utilization. Taking into account that the WSC concentration tends to increase over the day (Smith, 1973; Wilkinson *et al*., 1994; Avondo *et al*., 1996a) through the accumulation of the products of photosynthesis, a trial has been carried out to evaluate the effect of varying the time of grazing on herbage intake, diet selection and chemical composition of goat milk.

Materials and methods

Experimental procedure

In a hilly semi-arid area of Sicily, sixteen Girgentana goats at 135±4.4 day of lactation were homogeneously divided into 2 groups on the basis of milk yield, body weight and BCS (body condition score). The experiment began on 15th April after a 10-day pre-experimental period and lasted 5 weeks. The goats were housed in individual pens were they received 500 g/d of barley grain. Each group was left to graze on a fenced plot of a ryegrass sward (*Lolium multiflorum* Lam. subsp. *Westerwoldicum,* var. Elunaria*)*, during vegetative phase, at a stocking rate of 64 goats/ha, as follows: group 1, from 9:00 to 13:00; group 2, from 12:00 to 16:00.

Data collection

Over a 10-day pre-experimental and a 40-day experimental period, once a week, the following measurements have been taken: undisturbed sward surface height, measured by sward stick; herbage mass and herbage sample collection, by clipping 4 square areas of 0.72 m^2 per plot at ground level; herbage DM intake and the *in vivo* DM digestibility of grazing goats, by the *n*-alkane method (Mayes *et al.*, 1986); selected herbage sample collection by hand-plucking 3 herbage samples for each group after observing the selective behaviour of goats during grazing (D'Urso *et al*., 1998); individual daily milk yield and milk sample collection.

Chemical analysis

Analysis for DM, crude protein (CP), fat, ash (AOAC, 1984) and structural carbohydrates (Van Soest *et al*., 1991) was carried out on forage and barley. WSC concentration was determined by a modified anthrone method (Deriaz, 1961).

Selected herbage and faeces were processed for *n*-alkane analysis by gas-chromatograph. Milk samples were analysed for: lactose, fat, protein and somatic cells (Combifoss 5200); total N, non-casein N, non-protein N; urea (differential pH-metry).

Statistical analysis

Mean individual data were analysed using the GLM procedure of SPSS (SPSS for Windows, SPSS Inc., Chicago, IL) with the following model:

$$Y_{ij} = \mu + GT_i + BX_{ij} + \varepsilon_{ij}$$

Where Y_{ij} is a dependent variable, μ is the overall mean, GT_i is the effect of grazing time of day, BX_{ij} is the covariate term to adjust for pre-treatment, and ε_{ij} is the random error. The pre-treatment means of milk production and composition and dry matter intake were used as a covariate. When covariate was not significant ($P>0.05$) it was removed from the model.

Results and discussion

Chemical composition of herbage (Table 1) was not modified by time of day, except for WSC that resulted 25% higher in the afternoon group. Similar results on ryegrass, have been reported by Orr *et al.* (1997 and 2001) even though the WSC increase was slightly lower. Initial biomass resulted 4.1 and 2.6 t DM/ha respectively in am and pm plots, with a corresponding mean herbage height of 36.6 and 21.0 cm.

Table 1. Chemical composition of whole herbage and standard deviation

	9:00-13:00	12:00-16:00
Dry matter %	17.08±4.74	17.07±4.11
Crude protein %DM	10.79±1.65	9.46±1.73
NDF %DM	53.57±3.82	50.28±8.62
Lignin %DM	2.39±0.57	2.44±1.02
Ether extract %DM	2.24±0.47	2.29±0.28
WSC %DM	21.7±3.86	27.1±9.63

Table 2 reports the chemical composition of the diets selected at pasture. A strong selective activity has been observed in both groups. Compared to whole herbage composition reported in Table 1, crude protein and ether extract were much higher and NDF and lignin were lower in the selected diets. WSC content resulted lower in the selected portions than in the whole plant, despite the preference for sweet taste generally showed by ruminants. These findings should be a consequence of a marked preference that goats showed for leaves, easier to chew and highly digestible; in fact, as previous studies report (Avondo *et al*., 1995, 1996b; Smith *et al*., 2001), WSC content in grass leaves is lower than in pseudostems and shoots.

Table 2. Chemical composition of diets selected at pasture

	9:00-13:00	12:00-16:00
Dry matter %	15.87±1.71	16.71±1.65
Crude protein %DM	19.83±2.25	16.72±2.56
NDF %DM	40.29±7.12	42.57±1.79
Lignin %DM	2.18±0.74	1.93±0.82
Ether extract %DM	3.97±0.49	3.78±0.56
WSC g/kg DM	17.4±1.92	204.4±3.30

Grazing behaviour was affected by time of day. DM and WSC intakes (Table 3) significantly increased in the afternoon group; on the contrary, protein intake slowly increased in the morning group even not significantly. This is an effect of the higher crude protein level of the diet selected by goats grazing from 9:00 to 13:00 that compensated the lower DM intake levels. As in both groups the goats similarly selected the leaves, rejecting the stems, the differences in chemical composition found between the selected diets are likely to be linked to diurnal variations in leaves chemical composition.

Table 3. Intake at pasture (g/d)

	9:00-13:00	12:00-16:00	P
Dry matter	748,4	825.4	0.01
Crude protein	154.7	144.7	0.11
NDF	300.4	348.2	<0.01
WSC	129.8	166.8	<0.01

Table 4 reports the results on milk production and composition. Fat normalized milk production, fat and lactose content were not affected by treatment.

Taweel *et al*. (2005), on testing two varieties of perennial ryegrass at different WSC content on dairy cows, have not found any significant difference in milk production and quality. The authors ascribe the lack of significance to the low difference in WSC content between the two grass varieties, that ranged from 24 to 31 g/kg of DM. In our experimental conditions, with a difference in the content

of WSC in the available herbage equal to 54.2 g/kg of DM, protein and casein levels significantly increased in the afternoon group, whereas urea significantly decreased. These findings seem to indicate that an improvement of ruminal conversion efficiency of pasture N to microbial N has been obtained according to higher WSC availability.

Table 4. Adjusted means of FCM[†] and milk composition

	9:00-13:00	12:00-16:00	P≤
FCM g/d	893.1	931.4	0.09
Fat %	4.06	3.94	0.47
Protein %	3.42	3.56	0.01
Lactose %	4.62	4.57	0.91
Casein %	2.65	2.78	0.04
Urea mg/dl	38.0	35.9	0.05

[†]Milk corrected for fat (5%); FCM = milk (g/d) × (0.5481 + 0.0904 × % milk fat) (Pulina *et al*., 1991)

Conclusions

Goats showed a strong selective activity that further increased the high soluble protein input generally occurring with fresh herbage. For this reason, the animals seem to take advantage of the increased WSC levels, deriving by shifting grazing time from morning to afternoon, not only in terms of N utilization at the level of the rumen, but also in terms of milk quality.

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